

Table 1: **Self-consistent muon collider ring parameter sets for Snowmass studies.** The final column is the 100 TeV Very Large Muon Collider (VLMC) “straw-man” parameter set and the middle column shows the range of parameters for the straw-man parameter sets assuming a muon collider using acceleration from an existing TeV-scale e+e- linear collider linac (mu-LC). The individual parameter sets for the TESLA and NLC mu-LCs are given individually in the 2 following tables. “Straw-man” means that studies and constructive criticism are invited in order to determine the feasibility or otherwise of the parameter sets. For comparison, the first column displays the range of the corresponding parameters from the muon colliders at 0.1, 0.4 and 3 TeV that are discussed in the paper: The Muon Collider Collaboration, *Status of Muon Collider Research and Development and Future Plans*, Phys. Rev. ST Accel. Beams, 3 August, 1999. The parameters in column 1 that were not provided in that reference have been either estimated or reconstructed for consistency with those parameters that were provided. (B. King; revised 13 July, 2001)

parameter set center of mass energy, E_{CoM}	MCC Status Rep. 0.1 to 3 TeV	mu-LC 1.6 to 11.2 TeV	VLMC 100 TeV
collider physics parameters:			
luminosity, \mathcal{L} [$10^{34} \text{ cm}^{-2} \cdot \text{s}^{-1}$]	$8 \times 10^{-4} \rightarrow 5.0$	1.0	20
$\int \mathcal{L} dt$ [fb $^{-1}$ /year]	0.08 → 540	100	2000
No. of $\mu\mu \rightarrow ee$ events/det/year	650 → 10 000	70 → 3400	17
No. of 100 GeV SM Higgs/year	4000 → 600 000	85 000 → 140 000	4.2×10^6
CoM energy spread, σ_E/E [10^{-3}]	0.02 → 1.1	1.8 → 3.2	0.28
collider ring parameters:			
circumference, C [km]	0.35 → 6.0	3.0 → 11.7	200
ave. bending B field [T]	3.0 → 5.2	5.6 → 10.5	5.2
beam parameters:			
(μ^- or) μ^+ /bunch, $N_0[10^{11}]$	20 → 40	0.2 → 9	7
(μ^- or) μ^+ bunch rep. rate, f_b [Hz]	15 → 30	0.45 → 1750	10
P.S. density, $N_0/\epsilon_{6N}[10^{22} \text{ m}^{-3}]$	1.2 → 2.4	2.4 → 4.7	0.80
6-dim. norm. emit., $\epsilon_{6N}[10^{-12} \text{ m}^3]$	170	0.83 → 19	88
$\epsilon_{6N}[10^{-6} \text{ m}^3 \cdot \text{MeV}/\text{c}^3]$	200	0.98 → 22	104
x,y emit. (unnorm.) [$\pi \cdot \mu\text{m.mrad}$]	3.5 → 620	0.085 → 3.0	0.016
x,y normalized emit. [$\pi \cdot \text{mm.mrad}$]	50 → 290	3.9 → 23	7.6
long. emittance [10^{-3} eV.s]	0.81 → 24	5.7 → 37	530
fract. mom. spread, δ [10^{-3}]	0.030 → 1.6	2.5 → 4.5	0.40
relativistic γ factor, E_μ/m_μ	470 → 14 000	7600 → 53 000	470 000
time to beam dump, $t_D[\gamma\tau_\mu]$	no dump	0.5 → 1.0	no dump
effective turns/bunch	450 → 780	630 → 990	780
ave. current [mA]	17 → 30	0.15 → 14	3.5
total beam power [MW]	1.0 → 29	0.7 → 11.2	110
synch. rad. critical E [MeV]	$5 \times 10^{-7} \rightarrow 8 \times 10^{-4}$	$2 \times 10^{-4} \rightarrow 0.02$	0.9
synch. rad. E loss/turn [GeV]	$7 \times 10^{-9} \rightarrow 3 \times 10^{-4}$	$5 \times 10^{-5} \rightarrow 0.03$	13
synch. rad. power [MW]	$1 \times 10^{-7} \rightarrow 0.010$	$4 \times 10^{-4} \rightarrow 0.016$	44
beam + synch. power [MW]	1.0 → 29	0.7 → 11.2	160
power density into magnet liner [kW/m]	1.0 → 1.7	0.014 → 0.82	0.42
interaction point parameters:			
spot size, $\sigma_{x,y}$ [μm]	3.3 → 290	0.28 → 1.4	0.36
bunch length, σ_z [mm]	3.0 → 140	0.53 → 1.0	8.0
$\beta_{x,y}^*$ [mm]	3.0 → 140	0.53 → 1.0	8.0
ang. divergence, σ_θ [mrad]	1.1 → 2.1	0.31 → 2.2	0.045
beam-beam tune disruption, $\Delta\nu$	0.015 → 0.051	0.004 → 0.081	0.100
pinch enhancement factor, H_B	1.00 → 1.01	1.00 → 1.08	1.11
beamstrahlung frac. E loss/collision	negligible	negligible	1.2×10^{-7}
neutrino radiation parameters:			
collider reference depth, D[m]	10 → 300	200 → 650	100
ave. rad. dose in plane [mSv/yr]	$2 \times 10^{-5} \rightarrow 0.02$	$(0.9 - -2.9) \times 10^{-3}$	18
str. sec. len. for 10x ave. rad. [m]	1.3 → 2.2	0.63 → 1.0	8.4
ν beam distance to surface [km]	11 → 62	51 → 87	36
ν beam radius at surface [m]	4.4 → 24	1.9 → 6.7	0.075

Table 2: **Straw-man collider ring parameter sets for muon colliders using acceleration through the TESLA-800 linac (2001 Technical Design Report parameters), for Snowmass studies.** The parameters are for 1,2,3,5 and 7 passes of both muon signs through both linacs, respectively, corresponding to 1.6, 3.2, 4.8, 8.0 and 11.2 TeV center-of-mass energies. For each parameter set, the worst-case neutrino radiation averaged around the collider plane was fixed at 9×10^{-4} mSv/year, where 1 mSv/year is the U.S. legal limit, and the luminosity was fixed at $\mathcal{L} = 1 \times 10^{34} \text{ cm}^{-2} \cdot \text{s}^{-1}$. (B. King; revised on 13 July, 2001)

collider colliding projectiles center of mass energy, E_{CoM} [TeV]	TESLA e^+e^- 0.8	mu-TESLA				
		$\mu^+\mu^-$ 1.6	$\mu^+\mu^-$ 3.2	$\mu^+\mu^-$ 4.8	$\mu^+\mu^-$ 8.0	$\mu^+\mu^-$ 11.2
collider physics parameters:						
luminosity, $\mathcal{L} [10^{34} \text{ cm}^{-2} \cdot \text{s}^{-1}]$	5.8	1.0	1.0	1.0	1.0	1.0
$\int \mathcal{L} dt [\text{fb}^{-1}/\text{year}]$	580	100	100	100	100	100
R units: no. $\mu\mu \rightarrow ee$ evt./det/year	80 000	3400	850	380	140	70
No. of (115 GeV) SM Higgs/year	$\sim 400 000$	85 000	100 000	120 000	130 000	130 000
CoM energy spread, $\sigma_E/E [10^{-3}]$	43 (= δB)	2.5	2.3	2.1	1.9	1.8
collider ring parameters:						
circumference, C [km]	–	3.0	5.0	6.5	9.0	11.7
ave. bending B field [T]	–	5.6	6.7	7.7	9.3	10.0
beam parameters:						
beam energy, E_μ [TeV]	0.4	0.8	1.6	2.4	4.0	5.6
relativistic γ factor, E_μ/m_μ	783 000	7570	15 100	22 700	37 900	53 000
(μ^- or) μ^+ bunch rep. rate, f_b [Hz]	19 544	104	24	7.0	1.1	0.45
(μ^- or) μ^+ /bunch, $N_0 [10^{11}]$	0.14	2.0	3.0	4.0	7.0	9.0
P.S. density, $N_0/\epsilon_{6N} [10^{22} \text{ m}^{-3}]$		2.4	3.0	3.5	4.0	4.7
6-dim. norm. emit., $\epsilon_{6N} [10^{-12} \text{ m}^3]$		8.3	10	11	18	19
$\epsilon_{6N} [10^{-6} \text{ m}^3 \cdot (\text{MeV}/c)^3]$	1.2×10^{-9}	9.8	12	13	21	22
x,y emit. (unnorm.) [$\mu\text{m.mrad}$]		3.0	1.1	0.65	0.41	0.23
x,y normalized emit. [mm.mrad]		23	17	15	15	12
x,y normalized emit. [mm.MeV/c]	$(4000/8) \times 10^{-6}$	2.4	1.7	1.6	1.6	1.3
long. emittance [10^{-3} eV.s]	0.5	5.7	13	18	26	46
fract. mom. spread, $\delta [10^{-3}]$	0.6 before coll.	3.5	3.2	3.0	2.7	2.5
time to beam dump, $t_D [\gamma\tau_\mu]$		1.0	0.5	0.5	0.5	0.5
effective turns/bunch		720	630	730	880	940
ave. current [mA]		7.0	1.8	0.81	0.27	0.15
synch. rad. E loss/turn [MeV]		0.05	0.5	2	11	34
synch. rad. power [kW]		0.4	0.9	2	3	5
total beam power [MW]	34	5.3	3.7	2.2	1.0	0.7
decay power into beam pipe [W/m]		600	150	70	28	14
interaction point parameters:						
rms spot size, $\sigma_{x,y}$ [μm]	0.39/0.003	1.4	0.91	0.70	0.54	0.48
rms bunch length, σ_z [mm]	0.3	0.61	0.76	0.76	0.72	1.0
$\beta_{x,y}^*$ [mm]	15/0.4	0.61	0.76	0.76	0.72	1.0
rms ang. divergence, σ_θ [mrad]		2.2	1.2	0.93	0.75	0.48
beam-beam tune disruption, $\Delta\nu$		0.010	0.020	0.029	0.049	0.081
pinch enhancement factor, H_B		1.000	1.000	1.000	1.01	1.08
beamstr. frac. E loss/collision [10^{-8}]		0.01	0.1	0.5	5	11
neutrino radiation parameters:						
collider reference depth, D[m]		200	320	400	500	650
ν beam distance to surface [km]		51	64	71	80	91
ν beam radius at surface [m]		6.7	4.2	3.1	2.1	1.7
max. dose: in-plane ave [10^{-3} mSv/yr]		0.9	0.9	0.9	0.9	0.9
str. sec. len. for 0.01 mSv/yr max. [m]		1.3	1.1	0.9	0.8	0.7

Table 3: Straw-man collider ring parameter sets for muon colliders using acceleration through the 1 TeV NLC linac (NLC2001 parameter set B for 2.8 ns bunch spacing), for Snowmass studies. The parameters are for 1 to 5 passes of both muon signs through both linacs, corresponding to 2–10 TeV center-of-mass energies. For each parameter set, the worst-case neutrino radiation averaged around the collider plane was set to within the range $(0.9 \text{--} 2.9) \times 10^{-3}$ mSv/year, where 1 mSv/year is the U.S. legal limit, and the luminosity was fixed at $\mathcal{L} = 1 \times 10^{34} \text{ cm}^{-2} \cdot \text{s}^{-1}$. The number of particles per bunch in each parameter set has been reduced by approximately a factor of 10 from the approximately corresponding TESLA parameter set because the 11.4 GHz NLC cavities are much smaller than in the 1.3 GHz TESLA design and so cannot transport as much charge per bunch. (B. King; 10 June, 2001)

collider colliding projectiles center of mass energy, E_{CoM} [TeV]	NLC e^+e^- 1.0	$\mu^+\mu^-$ 2.0	$\mu^+\mu^-$ 4.0	$\mu^+\mu^-$ 6.0	$\mu^+\mu^-$ 8.0	$\mu^+\mu^-$ 10.0
collider physics parameters:						
luminosity, \mathcal{L} [$10^{34} \text{ cm}^{-2} \cdot \text{s}^{-1}$]	1.08	1.0	1.0	1.0	1.0	1.0
$\int \mathcal{L} dt$ [fb $^{-1}$ /year]	108	100	100	100	100	100
R units: no. $\mu\mu \rightarrow ee$ evt./det/year		2300	540	240	140	90
No. of (115 GeV) SM Higgs/year/det.		90 000	110 000	120 000	130 000	140 000
CoM energy spread, σ_E/E [10 $^{-3}$]	81 (= δB)	3.2	2.8	2.5	2.1	1.8
collider ring parameters:						
circumference, C [km]	–	3.2	5.0	6.7	8.7	10.0
ave. bending B field [T]	–	6.5	8.4	9.4	9.6	10.5
beam parameters:						
beam energy, E_μ [TeV]	0.5	1.0	2.0	3.0	4.0	5.0
relativistic γ factor, E_μ/m_μ	978 000	9500	18 900	28 400	37 900	47 300
(μ^- or) μ^+ bunch rep. rate, f_b [Hz]	11 400	1750	360	116	42	20
(μ^- or) μ^+ /bunch, $N_0[10^{11}]$	0.082	0.2	0.3	0.4	0.6	0.8
P.S. density, $N_0/\epsilon_{6N}[10^{22} \text{ m}^{-3}]$		2.4	3.0	3.6	4.1	4.7
6-dim. norm. emit., $\epsilon_{6N}[10^{-12} \text{ m}^3]$		0.83	1.0	1.1	1.5	1.7
$\epsilon_{6N}[10^{-6} \text{ m}^3 \cdot (\text{MeV}/c)^3]$		0.98	1.2	1.3	1.7	2.0
x,y emit. (unnorm.) [$\mu\text{m.mrad}$]		0.64	0.24	0.14	0.11	0.085
x,y normalized emit. [mm.mrad]		6.1	4.5	3.9	4.0	4.0
x,y normalized emit. [mm.MeV/c]		0.64	0.48	0.42	0.43	0.43
long. emittance [10^{-3} eV.s]		8.0	17	25	31	37
fract. mom. spread, δ [10 $^{-3}$]		4.5	4.0	3.5	3.0	2.5
time to beam dump, $t_D[\gamma\tau_\mu]$		1.0	0.5	0.5	0.5	0.5
effective turns/bunch		840	790	880	910	990
ave. current [mA]		14	3.4	1.6	0.91	0.63
synch. rad. E loss/turn [MeV]		0.1	1.3	4.8	12	25
synch. rad. power [kW]		1.7	4.3	7.9	11	16
total beam power [MW]		11.2	6.9	4.5	3.2	2.6
decay power into beam pipe [W/m]		820	200	100	60	40
interaction point parameters:						
rms spot size, $\sigma_{x,y}$ [μm]	0.24/0.03	0.58	0.39	0.32	0.29	0.28
rms bunch length, σ_z [mm]	0.12	0.53	0.64	0.72	0.78	0.89
$\beta_{x,y}^*$ [mm]	12/0.12	0.53	0.64	0.72	0.78	0.89
rms ang. divergence, σ_θ [mrad]		1.1	0.61	0.44	0.37	0.31
beam-beam tune disruption, $\Delta\nu$		0.004	0.007	0.011	0.016	0.022
pinch enhancement factor, H_B		1.000	1.000	1.000	1.000	1.000
beamstr. frac. E loss/collision [10 $^{-8}$]		0.001	0.009	0.03	0.1	0.2
neutrino radiation parameters:						
collider reference depth, D[m]		300	350	400	500	600
ν beam distance to surface [km]		62	67	71	80	87
ν beam radius at surface [m]		6.5	3.5	2.5	2.1	1.9
max. dose: in-plane ave [10 $^{-3}$ mSv/yr]		2.0	2.4	2.9	2.9	2.9
str. sec. len. for 0.01 mSv/yr max. [m]		0.52	0.33	0.24	0.24	0.22